



Outline

- SACD AoEs, Organization, Metrics, etc.
- Sustainment and Growth of Systems Analysis as a Core Competency
- SACD Workforce and Budget Status
- SACD Programs and Collaborations
- Examples of Recent Studies
- Examples of Significant Capabilities
- Feedback from Branches (After Break)

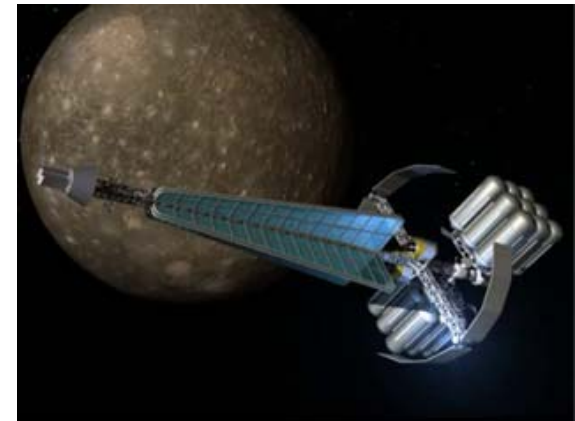
AoE-1: Advanced Mission, System Concept, & Architecture Studies

The conception, development, and planning of advanced aerospace missions and systems using advanced operations and system analyses that integrate contributions of required technical disciplines and systems



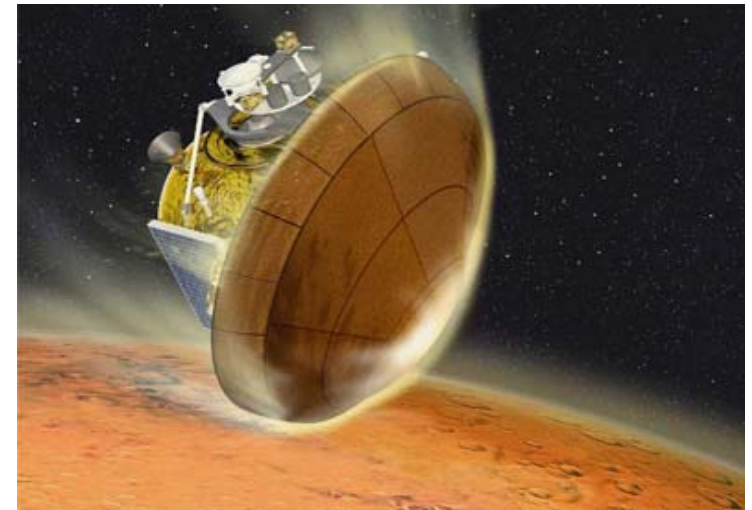
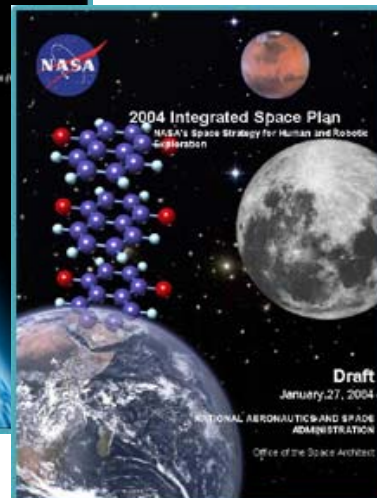
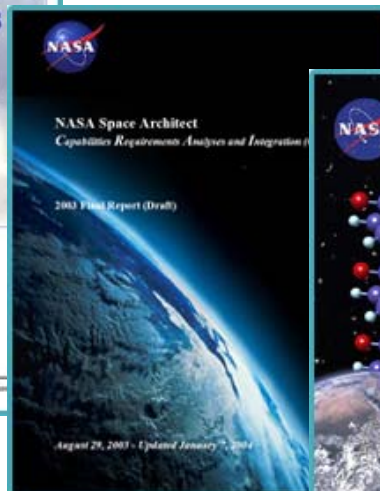
Products

- Mission Requirements
- Mission architecture and systems concepts
- Mission operational analysis
- Mission life cycle analysis



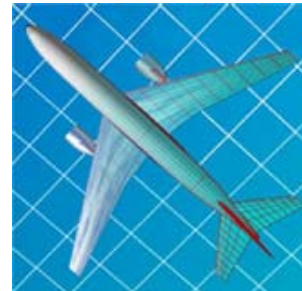
AoE-2: Aerospace Systems Concept Development & Technology Assessment

The development of aerospace vehicle and spacecraft concepts from a systems perspective to satisfy prescribed mission architectures and identification and prioritization of enabling technologies for performance, cost and safety



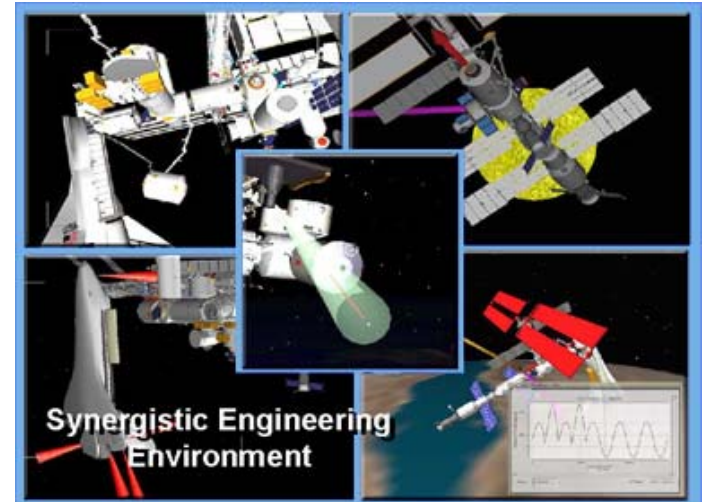
Products

- Conceptual design of advanced aerospace vehicle and spacecraft concepts
- System performance, cost, and risk analysis
- Enabling technologies and prioritization
- Technology investment portfolio



AoE-3: Advanced Analysis & Design Methods Development

Systems analysis and multidisciplinary design/optimization methods to enable mission planning and architecture, life cycle analysis, conceptual design of aerospace vehicles and spacecraft technology trades



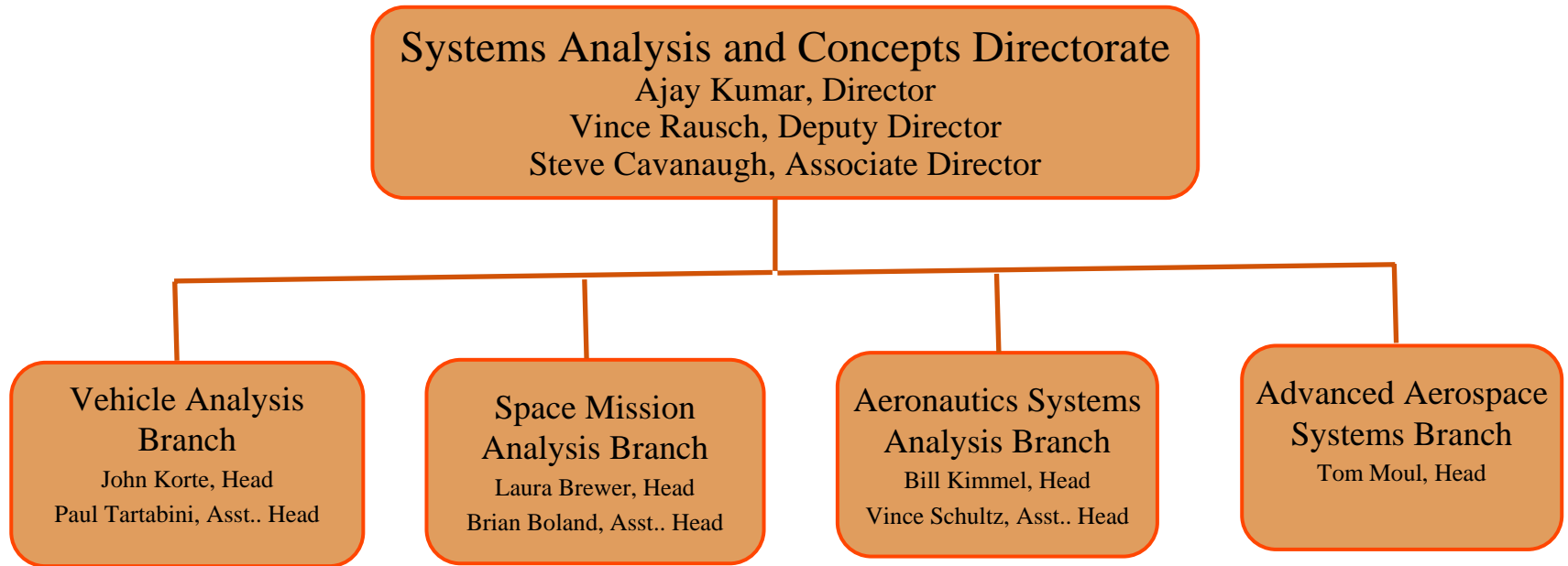
- Mission planning and architecture methods
- Systems analysis and design/optimization methods
- Life cycle analysis methods



SACD Organization



SACD



Systems Analysis - Strategic Directions



SACD

- ◆ **To increase our relevance to agency mission success, we will**
 - Grow systems analysis role in space exploration program
 - Build substantial role in newly-planned aeronautics program
 - Grow systems analysis role in science and space communication
 - Establish SACD as the systems analysis arm of HQ's PA&E Office
 - Grow collaboration with JPDO
 - Support HQ functional/program offices as “honest broker” (independent assessment and pre-decisional information)
- ◆ **Grow collaboration with NIA as SACD's strategic partner**
- ◆ **Sustain and Grow systems analysis as Center's core competency**
- ◆ **Grow reimbursable work in SACD (DoD, DHS, JPDO, Industry, etc.)**

SACD Performance Indicators



SACD

- ◆ Number of commitments met, or products delivered, within cost and schedule (Goal is to meet all commitments)
- ◆ Total number of quick-response requests that are received and worked each month
- ◆ Ratio of proposals won to proposals submitted (both number and dollar value)
- ◆ Number of safety-related incidents (goal is zero)
- ◆ Growth of reimbursable funds to 10% of the full-cost budget of SACD

SACD Review Process for Quality Assurance



SACD

◆ **Short and Urgent (911) Studies**

- Informal review within the Branch with personnel not involved in the study

◆ **Mid-Duration Studies**

- Formal review within SACD with Directorate personnel not involved in the study

◆ **Long-Duration (RASC, ASA, etc.) Studies**

- Formal review within SACD with personnel from SACD, Langley, and others not associated with the study

Sustainment/Growth of Systems Analysis as a Core Competency



SACD

- **Tools and Methods Assessment**

- What tools and methods are obsolete or redundant
- Whether they represent the state of the art
- Where do we have gaps in our tools and methods and how can we fill those gaps
- How many codes were developed and/or significantly modified by CS employees
- For how many codes, do we have expert users in CS employees

- **Documentation of significant capabilities of SACD**

- Planning to organize a technical session in Sept. 06 on "Systems Analysis Capabilities at NASA Langley" at the 11th AIAA /ISSMO Multidisciplinary Analysis & Optimization Conference in Portsmouth, VA
- Will help in marketing our capabilities as well as in identifying gaps as we document these capabilities

- **Implementation of significant recommendations from the recent Peer Review**

- **NIA Visitors Program**

- Short Courses and Lectures
- Short term visitors
- Workshops

- **NIA Langley Professors and "Rising Star Students" program for joint research**

- **SACD weekly Technical forums to share on-going studies amongst branches and to review completed studies**

Capability Documentation



SACD

- ◆ **SACD Capabilities Overview - Steve Cavanaugh**
- ◆ **Mission and Trade Study Analysis - Del Ricks**
- ◆ **Capability of Life Cycle Analysis on Space Vehicle Systems - Trina Chytka**
- ◆ **Decision Support Methods and Tools - Larry Green**
- ◆ **Technology Assessment/Portfolio Analysis - Steve Cavanaugh**
- ◆ **SACD Participation in Exploration Systems - Pat Troutman**
- ◆ **SACD Hyper-X Program Support - John Martin**
- ◆ **SACD Aeronautics Support - “Utilizing Traveler Demand Modeling to Predict Future Commercial Flight” - Jeff Viken**

NIA Visitors Program



SACD

◆ Short Courses

- Technology Engineering: Doug Stanley and Michelle Kirby (Dec. 5-6, 2005)
- Decision Analysis in Aerospace Design: Alan Wilhite and Doug Stanley (March 13-14, 2006)
- Supportability Engineering for Aerospace Systems: Ray Smiljanic (May 8-9, 2006)
- Space Flight Mechanics for Exploration Systems: Bob Tolson (July 12-13, 2006)
- Aerospace Transportation Systems Analysis: Alan Wilhite (Early August)

◆ Lectures and Summer Visitors

- Life-Cycle Cost Estimation for NASA's Exploration Systems Architecture Study, Joe Hamaker, NASA HQ (Feb. 10, 2006)
- Safety and Reliability Analysis for NASA's Exploration Systems Architecture Study, Joe Fragola, Valador Corp. (Feb. 28, 2006)
- Returning Humans to the Moon: What Do We Do After We Plant the Flag? James W. Head, Brown Univ. (March 22, 2006)

NIA Visitors Program (Cont.)



SACD

◆ Lectures and Summer Visitors

- Optimization on Cost Basis and Robust Design Approaches for Reducing Risk, Resit Unal, ODU (April 11, 2006)
- An Introduction to Cost Risk Analysis, Paul R. Garvey, MITRE (May 2, 2006)
- Human Space Systems Engineering, Jeff Hoffman, MIT (May 25, 2006)
- Expert Elicitation, Roger Cooke, Delft University of Technology, Netherlands (Late June)
- Conceptual Design of Aerospace Vehicles , Berndt Chudoba, Univ. of Texas, Arlington (Date TBD). Will also be spending one or two weeks as summer visitor, possibly in July.

SACD Workforce Status



SACD

- ◆ **SACD workforce situation became quite challenging**
 - Down from 118 in Oct. 2004 to 97 in March 2006 (even after several reassignments to SACD from other organizations)
- ◆ **Dissolved Multidisciplinary Tools and Methods Branch and reassigned personnel to other SACD Branches**
- ◆ **Successfully advocated to Center management for additional workforce. Approved for**
 - 9 co-op hires (only 5 accepted)
 - 11 reassignments
 - 3 critical hires
 - 3 conversions from term to perm
- ◆ **Additional workforce by Branch**

– SACD Office	1
– Vehicle Analysis Branch	7
– Space Mission Analysis Branch	5
– Aeronautical Systems Analysis Branch	2
– Advanced Aerospace Systems Branch	4

SACD FY06 Budget Chart



SACD

◆ FY'06 (10/05 Baseline) Workforce

80 CS FTEs (Program Direct)

18 CS FTEs (S&E Pool)

42 On-site Contractors

8 NIA Students

◆ FY'06 Current Workforce

90 CS FTE's (Program Direct) Bodies on Board

18 CS FTE's (S&E Pool)

42.5 On-site Contractors

{Includes 38 Direct funded and 4.5 Sys. Admin. (S&E Pool)}

8 NIA Students

Procurement Income

	FY06 (\$,M) anticipated	FY07 (\$,M) anticipated
Exploration	8.248	8.500
Aeronautics	3.710	3.800
Other (eg, FY06 S&E Pool, JPDO, SSO, DARPA)	2.529	3.000
Totals =	14.487	15.300

◆ FY'07 Projected Workforce

98 CS FTE's (Program Direct) Bodies on Board

18 CS FTE's (S&E Pool)

45 On-site Contractors

8 NIA Students

Projected FY'07 Programmatic Requirements

Exploration:	40.0 FTE's
Aeronautics:	50.0 FTE's
Science Support Office:	1.5 FTE's
Center G&A (B&P):	0.5 FTE's
S&E Pool:	18.0 FTE's
Other:	6.0 FTE's

Total: 116.0 FTE's

◆ FY'06 (initial) Full-cost budget required: \$28.356M

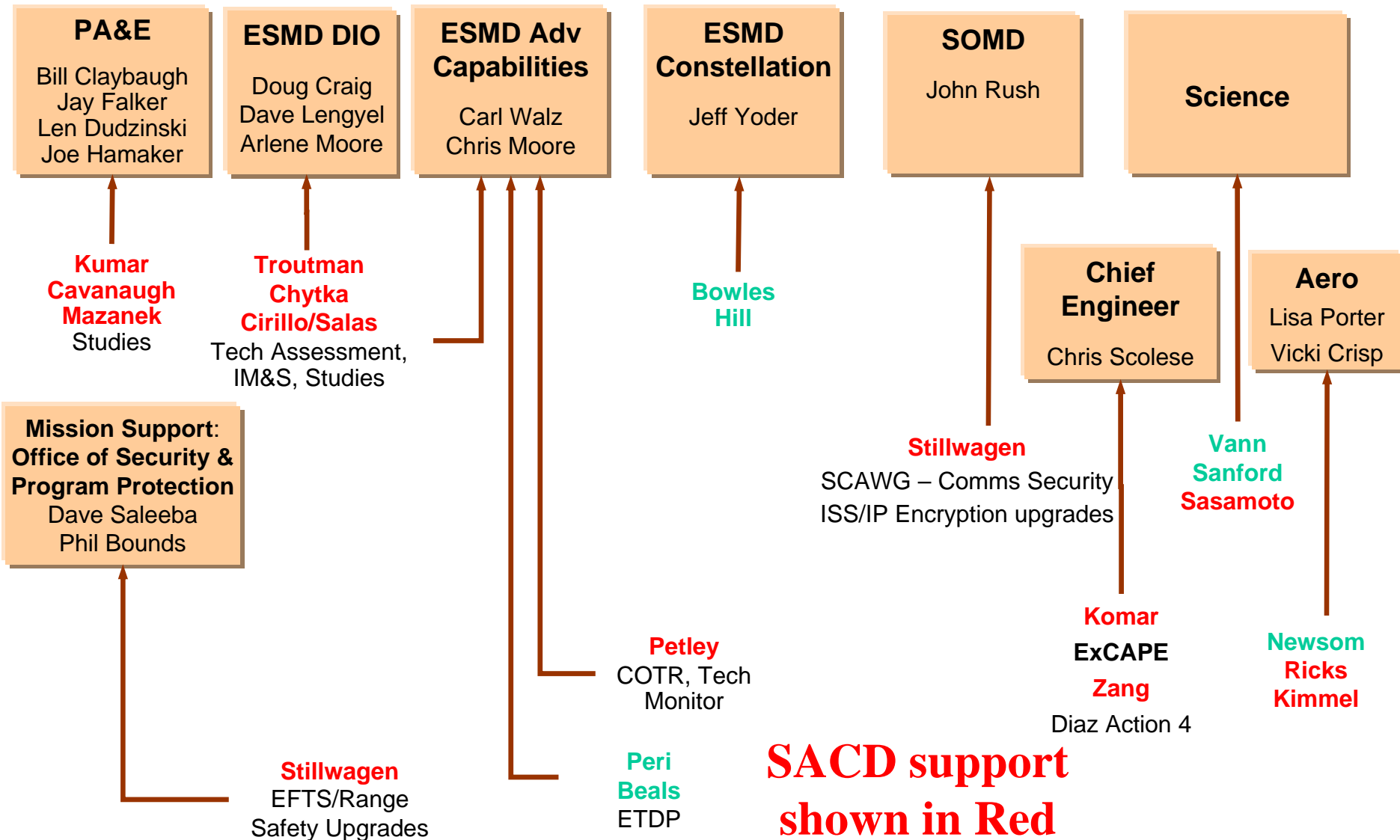
◆ FY'07 (projected) Full-cost budget required: \$33.511M

(98 x \$260K + 40.5 x \$190K + 8 x \$42K)

HQ Connections



SACD

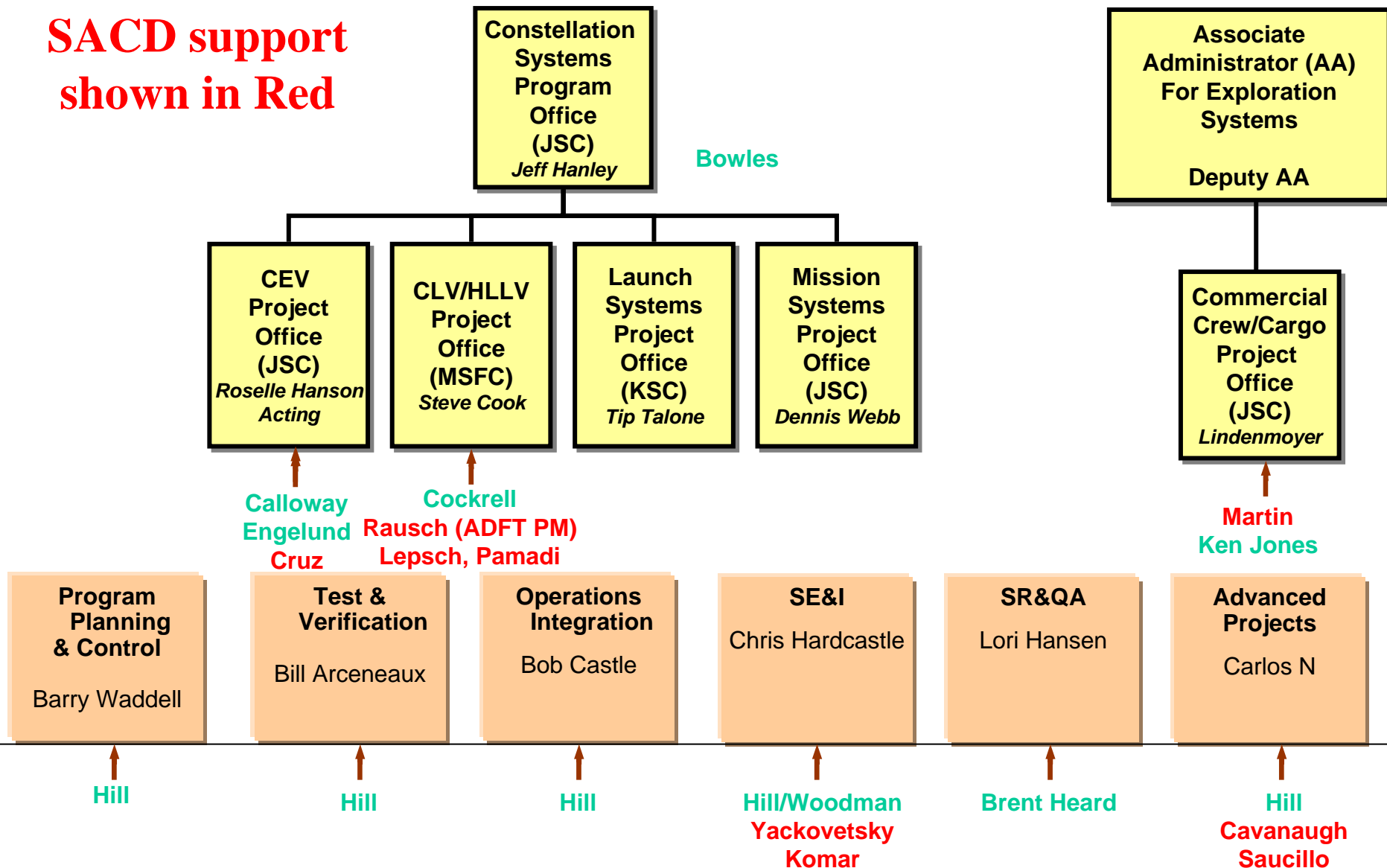




Constellation Connections

SACD

**SACD support
shown in Red**

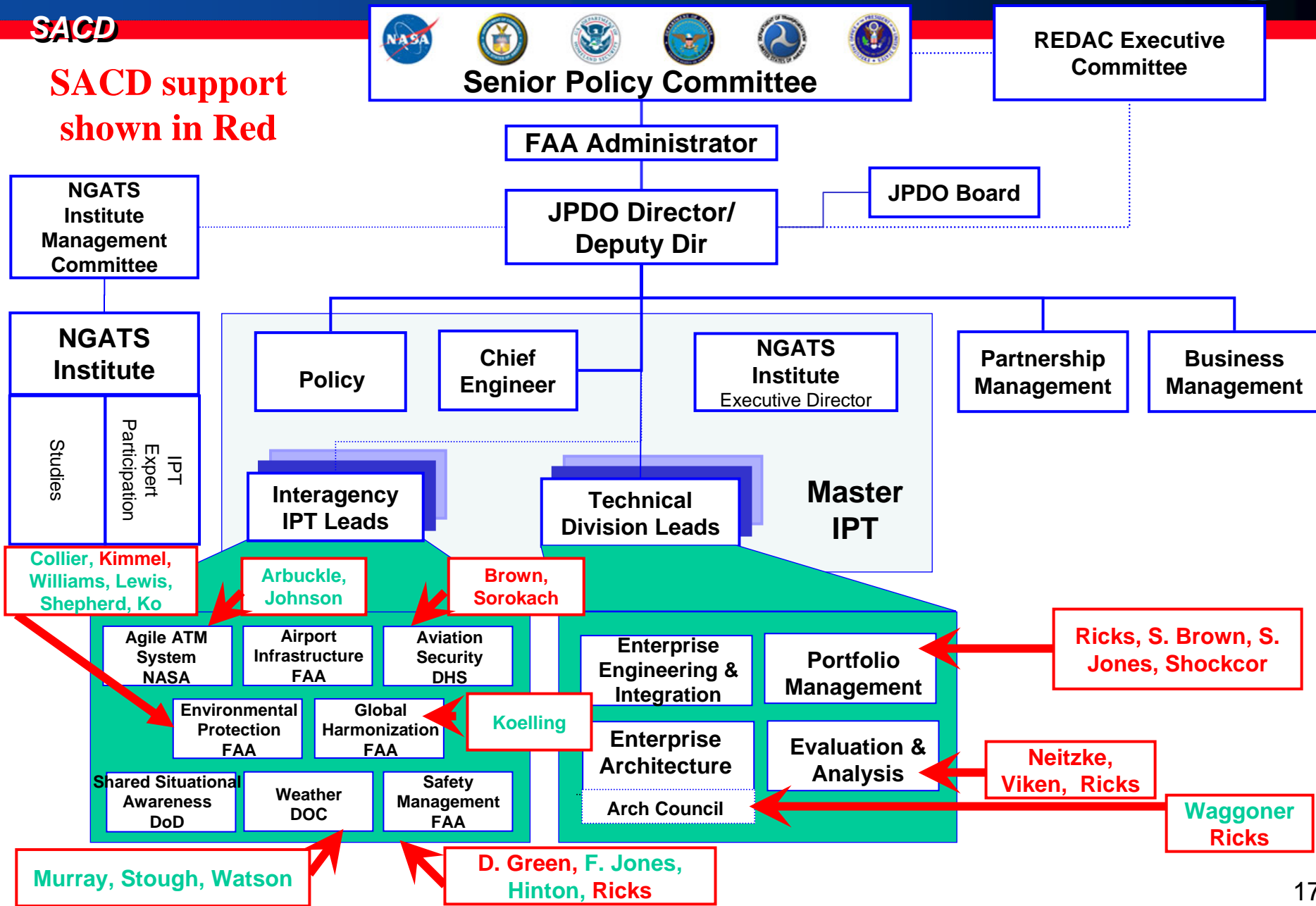


JPDO Connections



SACD

**SACD support
shown in Red**



SACD Role in Agency Programs



SACD

◆ **Exploration Systems Mission Directorate**

- **CEV**
 - **Aerothermal Heating Rates**
 - **CEV Heat Shield Carrier Structural Analysis**
 - **Modal Tests for Heat Shield Development**
- **CLV**
 - **Aero Database Development Lead**
 - **MSFC Tasks**
 - **Risk Based Design; CLV Trajectory Support; Alternate Methods for Vehicle Analysis; Upper Stage Trade Study Plan Support**
- **Constellation**
 - **SE&I: Flight Performance; Analysis, Trades & Architecture; Producability & Affordability**
 - **Advanced Project Office**
- **Strategic Systems Analysis for HQ**
 - **Task 11A: Tools Development for Modeling and Simulation and IM&S**
 - **Task 11B: Exploration Systems Analysis and Technology Assessment (Lead)**
 - **Possible additional funding from**
 - **GSFC to populate and maintain a Technology Assessment database and analysis capabilities (~7 FTE at LaRC)**
 - **KSC for a new risk and reliability tool (Funding to be used to augment an agency level strategic life-cycle analysis capability ~ 5 FTE at LaRC)**
- **LAS and ADFT**
- **Possible collaboration with SpaceDev under NASA's Commercial Orbital Transportation Services**

(Total FY07 FTE Level ~45)

SACD Role in Agency Programs (Cont.)



SACD

◆ **Aeronautics Research Mission Directorate**

- Fundamental Aeronautics Program (Participating in all 4 elements)
- Aviation Safety Program (Participating in 2 out 4 elements)
- Airspace Systems Program (Participating in both elements)
- Advanced Aircraft Program
- Possible collaboration with Dept. of Home Land Security on assessment of commercial aviation security risks relative to threats using the Logic Evolved Decision (LED) Support tool

(Total FY07 FTE Level ~ 50)

◆ **Science Mission Directorate**

- Proposal Evaluation
- ST-10 Technology Assessment (Proposed)
(~ 2 FTE)

◆ **Space Operations Mission Directorate**

- Space Communication Architecture
(~ 1 FTE)

◆ **Evaluation and Analysis Division (EAD)**

- Very light jets demand and impact studies
- Airspace operational concepts safety modeling test bed
- Comparison study of 4D airborne separation assurance system to advanced automation system bakeoff
- Fleet level noise and emissions studies (For EAD and Environmental IPT)

◆ **Aviation Safety IPT**

- General analysis support
- Strategic planning and leadership of a sub-team

◆ **Portfolio Management Division**

◆ **Environmental IPT**

- Development of environmental design space, EDS tools and ongoing IPT methods sub-team support

(~ 4 FTE level effort)

◆ Near Earth Object (NEO) Study

- Scope of the study is to identify and analyze alternatives for a NEO survey program to detect, track, catalogue, and characterize NEOs of >140m diameter and deflecting or otherwise mitigating the threat of a collision of a NEO with Earth
- Study team has three working groups
 - Detection, tracking, and cataloguing NEOs
 - Characterizing NEOs
 - Deflecting or otherwise mitigating the potential impact of a NEO
- SACD will provide analysis support to all three working groups between now and September

◆ NASA Exploration Safety Team

- Tom Zang completed a 3 months detail to PA&E serving on the NASA Exploration Safety Study Team and led a sub-team on Certification, Margins and Uncertainties
- The team was chartered by the Administrator and was led by Joe Fragola

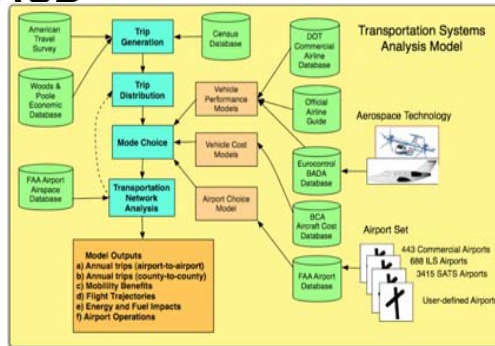
- ◆ **Tom Zang leading a team to develop a standard for the development, documentation, and operation of models and simulations**
 - Team's vision is a Standard that requires the NASA M&S development and operations communities to report their processes in such a manner that the decision-maker can **quantitatively** assess the associated risk for safety and mission assurance
 - The Standard will focus on the unique, critical aspects of M&S that are not covered by existing NASA software standards

- ◆ **Status**
 - The second draft of the M&S Standard is under circulation for comments
 - Changes to the second draft based on these comments will be incorporated into the third draft, which is the final deliverable to the NASA Technical Standards Working Group, by July 2006*

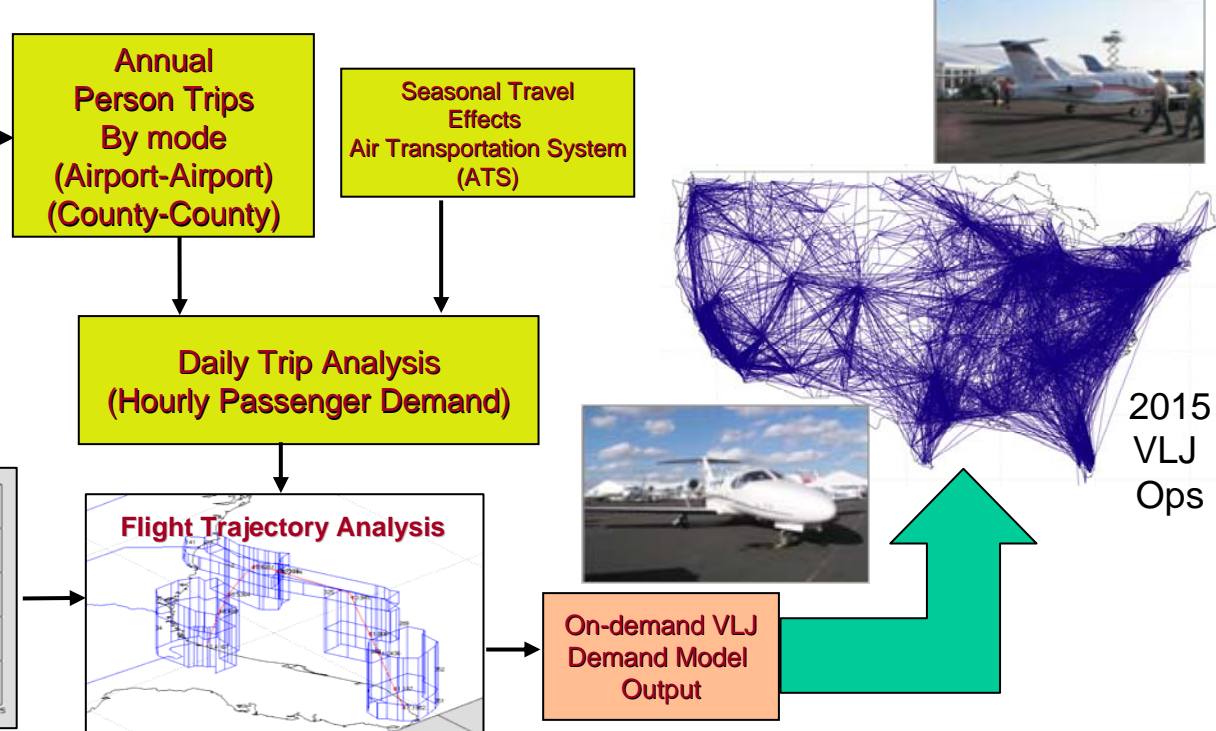
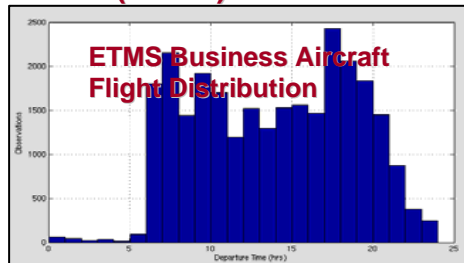
On-Demand Very Light Jets (VLJs) Trip Analysis



SACD



**Transportation
Systems Analysis
Model (TSAM)**



- ◆ Proliferation of VLJs requires the future system to accommodate many more flights
- ◆ Even without NGATS, the system seems able to accommodate these additional flights
 - No significant increase in flight eliminations due to the VLJs
 - Overall level of eliminations may still be a concern
 - *Conclusion (?)*: accommodation of these VLJ flights is possible due to their use at non-congested airports
- ◆ Effect of NGATS is to almost entirely accommodate demand in 2014 (even with VLJs added) and keep flight eliminations to less than 5% in 2025
- ◆ This analysis only gives insight into system-level performance; significant issues may arise at particular airports or airspace

◆ Objective:

- Examine how the ESAS architecture elements could be used to extend human presence across the solar system and other applications in support of science, DoD, and Commercial missions
 - Identifying uses of NASA exploration systems beyond exploration missions could result in cost sharing for development/operations and broader public and political support, thus enhancing robustness, affordability, and sustainability of exploration vision in the future

◆ Customer:

- Directorate Integration Office/ESMD, funded by Exploration Technology Development Program under the task “Exploration Systems and Technology Assessment”



Exploration Mission Synergy Assessments

Near Earth-Object Crewed Mission



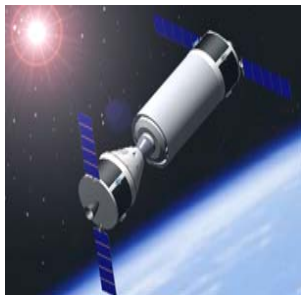
Unique and exciting mission beyond the Moon with broad public appeal. Extends human presence into interplanetary space and provides a stepping stone to Mars and beyond.

Propellant Transfer and In-Space Depot



Propellant transfer and propellant depots can extend the capability of Constellation elements via refueling of vehicles in LEO and LLO

Human Tended Free-Flyer



LEO facility for low gravity, long duration gravitational biology research in support of the Vision for Space Exploration

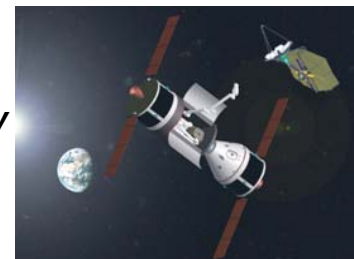


Spacecraft Deployment & Servicing



Multi-use space tug for transport through the 'Last Mile' to and from ISS to offload operational requirements

On-orbit servicing of telescopes at E-M L1 extends telescope lifetime and permits upgrades as technology advances



LARPS: Lunar Architecture Requirements Preparatory Study



SACD

◆ Objectives:

- Understand how requirements drive the lunar architecture's ability to support the surface exploration portion of the vision for space exploration
- Investigate concepts for reducing costs while enhancing figures of merit such as sustainability, science return and risk reduction from a campaign perspective

◆ Products:

- Reference architecture modeled for cost, risk, and integrated performance-architecture closure
- Key driving requirements identified and traded through variations in technologies, element configurations and concept of operations
- Advanced lunar campaign concept developed that features early outpost deployment and extensive lunar exploration
- Lunar architecture modeling capability and team in place ready to support the Exploration Strategic Planning activity

ExCAPE - An Assessment Tool for Exploration Campaigns & Architectures



SACD

- ◆ **ExCAPE is an engineering framework developed to enable broad trade space assessment of exploration campaigns & architectures**
 - Unique “front-end” toolset developed to facilitate rapid & consistent definition of campaign & architectures from customer-defined attributes
 - Architectural element sizing & mass properties modeled to the subsystem & component level → appropriate for conceptual & preliminary design environments (EXAMINE)
- ◆ **Current capability enables assessment of Lunar sortie & outpost architectures & campaign scenarios**
 - Quantitative sensitivity analysis & technology assessment
 - Campaign definition & FOM assessment
 - Architecture refinement & extensibility studies
- ◆ **Planned ExCAPE updates focus on models for assessing scenarios for permanent human presence on the Lunar surface & extending human presence beyond the moon**
 - Surface infrastructure & technologies (ISRU, SPS & ALS models)
 - Mars campaigns & architectures (interplanetary mission performance)
- ◆ **Future effort limited by funding to support core ExCAPE development team**

Today's LCA Capabilities



SACD

What are our current capabilities?

- **Formulation of mission requirements and concept of operations**
- **Conceptual economic analysis of the life cycle of an architecture**
 - DDT&E estimation
 - Acquisition estimation
 - Cost of ownership (operations, flight planning, logistical support, etc.)
 - Economic/cost uncertainty quantification
 - Assess cost implications and evaluate alternatives to achieve affordability
 - Provide system architects feedback to ameliorate high cost drivers
 - Adjust acquisition strategies
 - Adjust development profiles
 - Apply learning curves where applicable
- **Risk analysis to identify and assess system impacts**
 - Technical risk
 - Safety and Hazard Avoidance
 - Operational risk (reliability)
 - Schedule risk
 - Programmatic risk
- **Life cycle impact assessment and sensitivity analysis**

What do we want our capability to look like?

- **Ability to perform Life Cycle Analysis from conceptual to flight ready hardware (in all mission areas for Langley)**
- **Cutting edge on methodology development and tool utilization**
 - Ability to do tool development when gaps emerge
- **Familiar with costing/risk methods and tools used by other organizations and be smart enough to discern between them**
 - To defend your own methods you must know what else is going on in the community
- **Establish LCA as a discipline that is recognized as being as important to understanding the system as aero, structures, propulsion, etc.**



Working Well:

- ◆ **NIA partnership very strong**
 - NIA Classes and Lecture Series are excellent
- ◆ **New hires/reassignments/co-ops**
- ◆ **Supportive of building an LCA capability and communicating its importance to the Directorate and LaRC**
- ◆ **Administrative support - Excellent in Branches and Directorate**
- ◆ **Systems Administration - Computer Systems works well in Bldg. 1209**
- ◆ **Travel - Lot of flexibility in travel to develop customers**



Need Improvement:

- ◆ **Need a regular report from the Director's Office to the Staff**
 - Good opportunity to facilitate communications and team building
 - Discuss organization goals and how we do business
- ◆ **Need for a yearly State-of-Directorate talk to the Staff**
- ◆ **Technical Forums should be shortened**
- ◆ **Lack of communication between Branches**
 - Encourage employees to attend technical briefings
 - Use one of the larger conference rooms for these briefings
 - Branch Heads should visit other Branches
- ◆ **Definition of roles and responsibilities between the Director and Deputy Director**
- ◆ **Changes/chaotic environment**



SACD

Need Improvement:

- ◆ **Collaborations with universities**
 - Create a centralized effort/pool for securing funding
 - Cooperative agreements
- ◆ **Continued efforts on methods development and lessons learned**
- ◆ **Challenges in bringing in new employees**
 - Training and mentoring
 - Office space